Thermodynamics

1. **Hot Milk in a thermos flask is an example for**

   1) Isolated system 2) Open system 3) Closed system 4) Adiabatic system

2. **In open system, system and surroundings exchange**

   1) Energy only 2) Matter only 3) Both 1 &2 4) Neither 1 nor 2

3. **Which of the following is a state function?**

   1) Intrinsic energy 2) Enthalpy 3) Heat 4) Both 1 &2

4. **The standard heat of combustion of graphite carbon is -393.5 KJ mol^{-1}. The standard enthalpy of CO_2 is**

   1) +393.5 KJ mol^{-1} 2) -393. 5 KJ mol^{-1} 3) +196.75 KJ mol^{-1} 4) -196.75 KJ mol^{-1}

5. **Which of the following is a path function?**

   1) Internal energy 2) Enthalpy 3) Work 4) Entropy

6. **Mathematical representation of 1 st law of Thermodynamics is**

   1) Q = E +W 2) H = E+PV 3) W = Q xE 4)) $\Delta H = \Delta E + v\Delta P$

7. **Which of the following values of heat of formation indicates that the product is least stable?**

   1) -393.5 KJ 2) -972.7 KJ 3) +89.9 Kj 4) +272.2 KJ

   Hint: Endothermic compound is less stable. More endothermic is least stable.

8. **Enthalpy change in a cyclic process is**

   1) Infinite 2) Can't be predicted 3) Unity 4) Zero

9. **According to 1st law of Thermodynamics**

   1) Energy can be created but not destroyed

   2) Energy cannot be created but can be destroyed

   3) Energy can be created and destroyed

   4) Energy neither be created nor destroyed

10. **Internal energy does not include**

    1) Vibrational energy 2) Rotational Energy

    3) Energy due to gravitational pull 4) Potential Energy

11. At a given temperature internal energy of 4.4gm dry ice is

1) Same as 4.4gm liquid CO_2 2) Same as 4.4gm CO_2 gas

3) Same as 8.8gm dry ice 4) Same as 0.1 moles of dry ice

12. The change in internal energy of a system depends on

1) Initial and final states of the system 2) The Path if reversible

3) The path if irreversible 4) Initial, final states and also on the path

13. Enthalpy change during a reaction does not depend upon

1) Conditions of a reaction 2) Initial and final concentration

3) Physical states of reactants and products 4) Number of steps in the reaction

14. The standard enthalpies of n-pentane, isopentane and neopentane are -35.0, -37.0 and -40.0 K.cal/mole respectively. The most stable isomer of pentane in terms of energy is

1) n-pentane 2) Isopentane 3) Neopentane 4) Both 1 &2

15. The enthalpies of the elements in their standard states are arbitrarily assumed to be

1) Zero at 298 K and 1 atm 2) Unity at 298 K and 1 atm

3) Zero at all temperatures 4) Zero at 273 K and 1 atm

16. The standard enthalpy is zero for the substance

1) C (graphite) 2) C (diamond) 3) $CO_{2\ (gas)}$ 4) All

17. The heat required to raise the temperature of a body by 1^0C is called

1) Specific heat 2) Heat capacity 3) Water equivalent 4) Heat energy

18. In exothermic reaction

1) $H_R = H_P$ 2) $H_R > H_P$ 3) $H_R < H_P$ 4) $\Delta H = 0$

19. The incorrect IUPAC convention

1) Heat gained by system +ve sign 2) Work done by system - ve sign

3) Work done on the system +ve sign 4) Work done on the system -ve sign

20. Which of the following is an endothermic reaction?

1) $C + O_2 \rightarrow CO_2$ 2) $N_2 + O_2 \rightarrow NO$

3) $3H_2 + N_2 \rightarrow 2NH_3$ 4) $PCl_3 + Cl_2 \rightarrow PCl_5$

21 change in enthalpy and change in internal energy are equal at room temperature for

1) Combustion of glucose 2) Combustion of ethylene

3) Combustion of methane 4) Combustion of ethyl alcohol

22. The difference between heats of reaction at constant pressure and at constant volume for the reaction

$2C_6H_{6(l)} + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(l)$ at 25^0C in KJ is

1) -7.43 2) +3.72 3) -3.72 4) +7.43

Hint: $\Delta H = \Delta E + \Delta n\, RT$

$\Delta H - \Delta E = (-3) \times 8.314 \times 10^{-3} \times 298 = -7.43$Kj

23. For which of the following reactions $\Delta H = \Delta E - 2RT$

1) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ 2) $N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$

3) $NH_4HS_{(s)} \rightarrow NH_{3\,(g)} + H_2S_{\,(g)}$ 4) $PCl_{5(g)} \rightarrow PCl_{3(g)} + Cl_{2(g)}$

Hint: $\Delta H = \Delta E + \Delta n\, RT$

Given $\Delta H = \Delta E - 2RT$ i.e. $\Delta n = -2$

24. For which of these process is the value of ΔH negative

i) $N_2 + O_2 \rightarrow 2NO$

ii) $N_2 + 3H_2 \xrightarrow{Fe+Mo} 2NH_3$

iii) $2SO_2 + O_2 \xrightarrow{V_2O_5} 2SO_3$

iv) $H_2 + I_2 \xrightarrow{pt} 2HI$

1. i and ii are correct 2. ii and iii are correct

3. iii and iv are correct 4. i and iv are correct

25. Heat of neutralization is least when

1) NaOH is neutralised by CH_3COOH 2) NaOH is neutralised by HCl

3) NH_4OH is neutralised by CH_3COOH 4) NH_4OH is neutralised by HNO_3

26. For the reaction $C_2H_{4(g)}+3O_{2(g)}\rightarrow 2CO_{2(g)}+2\ H_2O_{(g)}$, the difference between enthalpy change and internal energy change is

1) -RT 2) +RT 3) -2RT 4) Zero

Hint: $\Delta H=\Delta E+\Delta n\ RT$

27. The following is not a combustion reaction

1) $CO+\frac{1}{2}O_2\rightarrow CO_2$ 2) $C+O_2\rightarrow CO_2$ 3 $C+\frac{1}{2}O_2\rightarrow CO$ 4) $CH_4+2O_2\rightarrow CO_2+2H_2O$

28. Match the following.

List -I	List-II
A) $\Delta H<0$	1) First law of thermodynamics
B) $\Delta H=\Delta E+\Delta nRT$	2) Heat of combustion
C) Bomb-calorimeter	3) Relationship between Q_p and Q_v
D) Hess law is based on	4) Exothermic reaction

Correct match

	A	**B**	**C**	**D**
1.	1	2	3	4
2.	4	3	2	1
3.	4	3	1	2
4.	3	1	4	2

29. $2H_{2(g)}+2Cl_{2(g)}\rightarrow 4HCl(g),\ \Delta H^0=-92.3kJ$

i) If the equation is reversed, the valueΔH^0 equal to +92.3Kj

ii) The four H-Cl bonds are stronger than the four bonds in $2H_2$ and $2Cl_2$

iii) The ΔH^0 value will be -92.3Kj if the HCl is produced as a liquid

1. All are correct 2. i Only correct 3. i and ii are correct 4. iii Only correct

30. The correct statement among the following

i) Heat of reaction depends on the temperature at which the reaction is carried

ii) ΔH for neutralization is always -Ve.

iii) Experimentally heat of combustion is ΔE.

1. i only correct 2. ii only correct 3. iii only correct 4. All are correct

31. Match the following.

List-I	List - II
A) solid→vapour	1) 32.8
B) $H_2 + Cl_2 \rightarrow 2HCl$ $\Delta H = -44$ K.cals heat of formation HCl (k.cal)	2) -22
C) Heat of combustion of Graphite is-393.5 k.J its Calorific value of (in k.J)	3) 1 calories
D) 4.184 Joules is equal to	4) Endothermic

Correct match is

	A	B	C	D
1.	1	2	3	4
2.	4	3	2	1
3.	4	2	1	3
4.	2	1	4	3

32. Match the following.

A) $HNO_3 + KOH$	i) 55.2 kJ per mol
B) $CH_3COOH + KOH$	ii) Path function
C) Internal Energy	iii) 57.3 kJ per mol
D) Work done	iv) State function

1) A-(iii), B-(i), C(iv), D(ii)

2) A-(i), B-(ii), C(iii), D(iv)

3) A-(ii), B-(i), C(ii), D(iv)

33. **Assertion (A)**: The enthalpy of formation of $H_2O_{(l)}$ is greater than that of $H_2O_{(g)}$

Reason (R): Enthalpy change is negative for the condensation reaction $H_2O_{(g)} \rightarrow H_2O_{(l)}$

1. Both assertion and reason are correct, reason is the correct explanation of the assertion.

2. Both assertion and reason are correct reason is the not correct explanation of the assertion.

3. A is correct, R is incorrect.

4. Both A and R are incorrect.

34. **Match the following.**

List-I	**List - II**
A) Heat of Hydration	1) Is an Intensive property
B) Heat of Transition	2) Is an Extensive property
C) Molar volume of a gas	3) ΔH is always -Ve
D) Volume of a gas	4) ΔH may be +Ve or -Ve

The correct match is

	A	**B**	**C**	**D**
1)	1	2	3	4
2)	4	3	1	2
3)	3	4	1	2
4)	2	1	4	3

35. **A gas contained a cylinder fitted with a friction less piston expands against a constant pressure 1atm from a volume of 2 liter to volume of 12 liter. In doing so, it absorbs 800J thermal energy from surrounding. Then the ΔEfor the process is**

1) - 213.7 J 2) - 112 J 3) - 50J 4) - 25 J

Solution: $W = -P \times \Delta V$ = -1X (12-2) =-10lit.atm =-10X101.37kj=-1013.7kj

$\Delta E = q - w$ =800-1013.7= -213.7Kj

36. 5moles of oxygen are heated at constant volume from 10^0 to 20^0C. The change in internal energy of a gas is?

$\left[C_P = 7.03 cal mol^{-1} des^{-1} \text{ and } R = 8.31 J mol^{-1} des^{-1}\right]$

1) 125cal 2) 252cal 3) 50cal 4) 500cal

Solution:

$C_P - C_V = R \quad C_V = 7.03 - 1.99 = 5.04$

Heat absorbed by 5mole of oxygen in heating from 10 to 20^0

$= 5 \times Cr \times \Delta T = 5 \times 5.04 \times 10 = 252 cal.$

Since the gas is heated at constant volume, no external work is done W = 0.

So change in internal energy will be equal to heat absorbed.

$\Delta E = q + W = 252 + 0 = 252 cal$

37. The amount of work done by 2mole of an ideal gas at 298K in reversible isothermal expansion from 10litre to 20litre is

1) -120J 2) - 2452J 3) -3434.9J 4) 2200J

Solution:

$W = -2.303 nRT \log \frac{V_2}{V_1}$

= -2.303 X2X8.314 X298Xlog (20/10) =-3434.9j

38. 5moles of an ideal gas at 27^0C expands isothermally and reversibly from a volume of 1L to 10L. The work done in KJ is

1) -14.7 2) -28.72 3) + 28.72 4) - 56.72

Solution:

$W = -2.303 nRT \log \frac{V_2}{V_1}$

= -2.303 X5X8.314 $X10^{-3}$ X300Xlog (10/1) =-28.7KJ

39. 10litres of an ideal gas confined to a volume of 10L is released into atmosphere at 300K where the pressure is 1bar. The work done by the gas is $(R = 0.083 L\ bar\ K^{-1} mol^{-1})$

1) 249L bar 2) 259L bar 3) 239L bar 4) 220L bar

Solution: $V_2 = \frac{nRT}{P} = 249L$, $W = P\Delta V = 1 \times (249 - 10) = 239 L\ bar$

40. 1mole of a gas is heated at constant pressure to raise its temperature by 1^0C. The work done in Joules is

1) -4.3 2) -8.314 3) -16.62 4) Unpredictable

Solution: W=-nRΔT $= -1 \times 8.314 \times 1 = -8.314J$

41. 3.0 moles of ideal gas is heated at constant pressure from 47^0C to 147^0C. Then the work expansion of gas is

1) - 2.494KJ 2) + 2.494KJ 3) - 10.5KJ 4) + 10.5KJ

Solution: W=-nRΔT

=-3X 8.314X10^{-3}(147-47)=-2.494KJ

42. The pKa values of four acids A, B, C and D are 9.14, 9.92, 2.86 and 1.3 respectively. The heat of neutralization is more in the following reaction

1) $A + NaOH \rightarrow .....$ 2) $B + NaOH \rightarrow ....$

3) $D + NaOH \rightarrow ....$ 4) $C + NaOH \rightarrow ....$

Solution: Lower P^k_a represents strong acid. The heat of neutralization is more for a strong acid.

43. The heats of neutralisation of acids A, B, C and D with NaOH are -13.5 K.cal, -12.7 K.cal, -11.8 K.cal, -12.4 K.cal respectively.

The weakest acid is

1) A 2) B 3) C 4) D

Solution: If the heat of neutralisation is lowest then the acid is weakest.

44. According to $H_2(g) + I_2(g) \rightarrow 2HI(g), \Delta H = 51.9 \ \ KJ.$ heat of formation of HI is

1) 51.9 KJ 2) -51.9 KJ 3) -25. 95 KJ 4) 25.95 KJ

Solution: heat of formation =ΔH per mole= (51.9/2)=25.95

45. The heat of formation of $H_2O_{(l)}$ is -286.2 KJ. The heat of formation of $H_2O_{(g)}$ is likely to be

1) -286.2 KJ 2) -290.78 KJ

3) -335.2 KJ 4) -242.76 KJ

Solution: $H_2O_{(l)} \rightarrow H_2O_{(g)}$ is an Endothermic process.

46. $NH_4Cl(s) + H_2O \rightarrow NH_4Cl(aq) \quad \Delta H = 16.3\,KJ$

ΔH in the above reaction represents

1) Heat of solution 2) Heat of hydration

3) Heat of dilution 4) Heat of ionization

47. A system absorbs 10 kJ of heat and does 4 kJ of work. The internal energy of the system would?

1) Decreases by 6 kJ 2) Increases by 6 kJ

3) Decreases by 14 kJ 4) Decreases by 14 kJ

Solution: q=10Kj, W=-4Kj thus ΔE= q+W= 10 -4=6Kj

48. When 4 grams of methane is completely burnt in oxygen, the heat evolved is 224 kJ. What is the heat of combustion (in KJ) of methane?

1) -1120 2) -968 3) -896 4) -560

Solution: Heat of Combustion= heat liberated per 1 mole

if 4gm of methane given 224KJ then 1mole i.e 16gm of methane gives (16/4)x224=896KJ.

49. One mole of ideal gas expands freely at 310 K from five liter volume to 10 liter volume. Then ΔE andΔ H of the process are respectively

1) 0 and 5 cal 2) 0 and 5 x 300 cal 3) 0 and 0 4) 5 and 0 cal

Hint: for an Ideal gas ΔH=o and ΔE=0

50. The heat of dissociation (in K.cals/mole) of CH_4 and C_2H_6 are 360 and 620 respectively. From these the C - C bond energy in the ethane can be evaluated as

1) 260 2) 130 3) 80 4) 200

Solution:

Average energy of C-H bond in CH_4=(360/4)=90

C_2H_6 has 6 C-H bonds and 1 C-C bond.

6C-Hbonds +1 C-C bond = 540

Energy of C-C = 620-(6C-H) =620-6X90=620-540 = 80K.cal

KEY

1)1	2)3	3)4	4)2	5)3	6)1	7)4	8)4	9)4	10)3
11)4	12)1	13)4	14)3	15)1	16)1	17)1	18)2	19)4	20)2
21)1	22)1	23)1	24)2	25)3	26)4	27)3	28)2	29)3	30)4
31)3	32)1	33)1	34)2	35)1	36)2	37)3	38)2	39)3	40)2
41)1	42)3	43)3	44)4	45)4	46)1	47)2	48)3	49)3	50)3